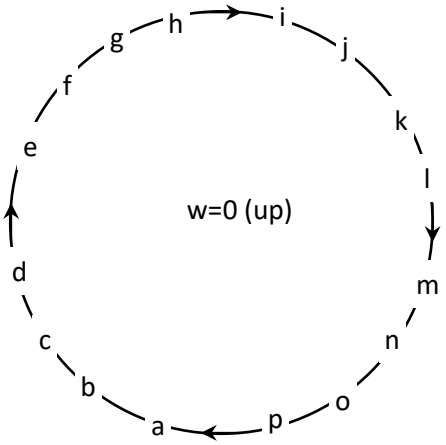
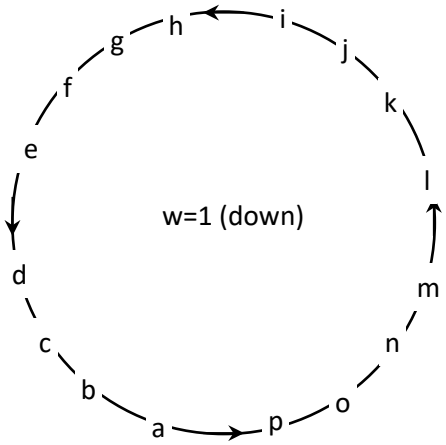
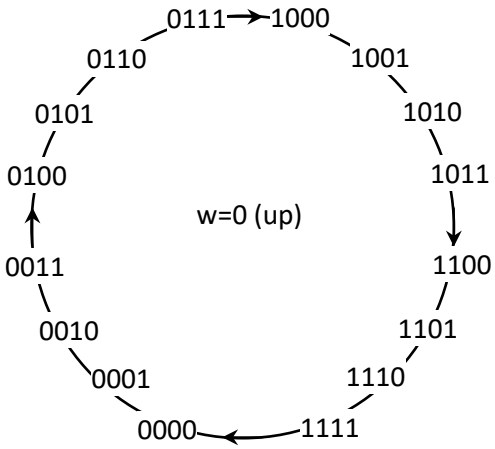
2020 Fall - ECE 2220 Laboratory 8: A Finite-State Machine – Up/Down Counter

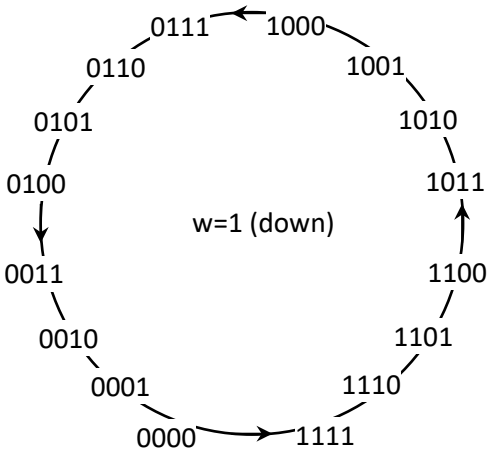
Instructions

1) Design a finite-state machine to generate the following sequence where the outputs and next state are dependent upon both the state of the circuit and the inputs. This is an up/down counter where the input (w) determines the direction of the counter. As show in the figure below, if the input, w=0, the sequence goes clockwise and if w=1, the sequence goes counter clockwise. The sequence just demonstrates a simple 4-bit up down counter.









a) Create a state table for this finite state machine for the up/down counter.

Present state	Next state	Output				
	w=0	w=1	w=0	w=1		

b) Explain how you could implement the same circuit with D flip-flops

Clock	D	Q(t+1)
0	0	Q
1	0	0
1	1	1

State assignment

Current state					Next state w=0					Next state w=1				
Assignment	d3	d2	d1	d0	Assignment	D3	D2	D1	D0	Assignment	D3	D2	D1	D0

D3(w=0)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

D3(w=1)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

$D3 =$ _____

D2(w=0)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

D2(w=1)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

$D2 =$ _____

D1(w=0)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

D1(w=1)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

$D1 =$ _____

D0(w=0)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

D0(w=1)

d3 d2 \ d1 d0	0 0	0 1	1 1	1 0
0 0				
0 1				
1 1				
1 0				

$D0 =$ _____

Using the any of the internal clocks, add a clock into your code such that the counter will count up or down at a 1 second interval. You will need to write a separate module for this. Use SW[0] to control the direction (up/down)of the counter and SW[9] as a reset which puts the counter back to zero. Use one of the LEDS in the middle show the state of the slow clock. Use the 1st and last LED to show the state of w and reset. Use one of the seven-segment displays to show the hexadecimal state of the machine. LEDs can be used to confirm the binary count and the slower clock. You may implement this counter using the D-latches as before or with some other "more efficient" code. Simulate the code and show it is working on the DE10 board.